

REMARKS

As an initial matter, the Applicants would like to thank the Examiner for allowing claims 1-3.

Claims 1-3 and 12-15 are pending in the application. Claims 4-11 have been canceled. Claim 15 has been newly added. Reconsideration of the rejection and allowance of the pending application in view of the following remarks are respectfully requested.

The present invention relates to a method for laser drilling a hole in a multi-layered sheet-like material without causing delamination of the layers. The method includes drilling through all layers of the material by at least one laser pulse having a first energy. The laser pulse having the first energy generates an inter-layer pull-off force that is smaller than an inter-layer adhesion force of the multi-layered sheet. The method also includes trimming a shape of the hole by at least one laser pulse having a second energy higher than the first energy.

In the Office Action of August 10, 2004, claims 12-14 were rejected under 35 U.S.C. §103(a) as being unpatentable over Ayrton (U.S. Patent No. 5,741,456) in view of Zahaykevich (International Pub. No. WO 86/02301) and Temple et al. (U.S. Patent No. 6,228,311). Applicants respectfully traverse this rejection for the following reasons.

Ayrton relates to a carbon fibre layer formed by unidirectional sub-layers. Because the sub-layers are unidirectional, when a laser is utilized to drill a hole therein, the heat from the laser is highly concentrated, and the laser is able to drill the hole

without delamination of the sub-layers or bursting or blistering of the outer surface of the layer. See col. 2, lines 53-56 and col. 3, lines 37-49.

The Examiner admits that Ayrton fails to disclose trimming a shape of the hole by at least one laser pulse having a second energy higher than the energy used to drill the hole. However, the Examiner states that Zahaykevich teaches using low-powered laser pulses to drill holes in a multi-layered sheet, and states that it would have been obvious to modify Ayrton's drilling process, such that low-powered pulses are used to drill holes, in order to avoid delamination. The Examiner further states that Temple teaches drilling a hole with an increased power at the end of a drilling process in order to trim the final shape of the hole, and that it would have been obvious to modify Ayrton's drilling process such that a second train of higher power pulses trim the drilled hole, in order to improve the internal finish of the drilled hole. The Examiner also specifically notes that Temple teaches maintaining a lower laser power at the beginning of the drilling process in order to avoid damage due to exhaust products, hence teaching a two-step laser drilling process.

Zahaykevich is directed towards a method for drilling holes in laminated materials which uses low-power pulses for the purpose of preventing delamination. However, at page 7, lines 4-13 (the portion cited by the Examiner), Zahaykevich teaches that different powered pulses are used for various layers of laminated material, in direct contrast to the recitations of claim 1.

Temple is directed towards a method for forming nozzles in a nozzle plate, which includes using a high laser power at the end of nozzle formation to give the nozzle a good internal finish. However, Temple does not appear to be directed to a laminated material and varies the pulse power while drilling through the material (i.e., as depth of the hole increases).

Further, Applicants respectfully submit that there is no motivation to combine the references as suggested by the Examiner. Ayrton specifically discloses that, due to the formation and/or structure of his carbon fibre layer, no delamination, bursting, or blistering occurs when a hole is drilled. Therefore, Applicants submit that there is no motivation to modify Ayrton with Zahaykevich's teaching such that low-powered pulses are used to drill the hole, since the formation and/or structure of Ayrton's multi-layered sheet eliminates the problem of delamination.

Furthermore, there is no suggestion by Ayrton that any trimming of the hole is necessary. However, assuming *arguendo*, that there were motivation to provide a second train of pulses to trim Ayrton's drilled hole, there would be no motivation to provide the second train of pulses with a higher energy than the energy used to drill the hole, since Ayrton's carbon fibre layer does not require low energy pulses to avoid delamination, bursting or blistering, as Temple's layer does. Accordingly, the rejection of claim 12 under 35 U.S.C. §103(a) over the combination of the Ayrton, Zahaykevich and Temple references is improper, and withdrawal thereof is respectfully requested.

In the Office Action, the Examiner also rejected claims 12-14 under 35 U.S.C. §103(a) as being unpatentable over Zahaykevich in view of Temple. Applicants also traverse this rejection for the following reasons.

Zahaykevich discloses that various sequences of pulse groups of voltages are used when drilling through a particular material with a number of layers. Zahakevich discloses that low-power pulses are used to begin the drilling, the power is increased towards the middle of the drilling, and then reduced towards the end of the drilling. See page 45, lines 7-23. However, Zahaykevich does not disclose or suggest, inter alia, the claimed feature of drilling through *all layers* by at least one laser pulse *having a first energy*.

Furthermore, Temple does not teach these features, and does not even appear to be directed towards a multi-layer structure. The portion of Temple cited by the Examiner (col. 7, lines 1-11) merely discloses varying the power of the laser while drilling through the material. Since neither Zahaykevich nor Temple disclose at least drilling through all layers of the material by at least one laser pulse having a first energy, the rejection of claim 12 under 35 U.S.C. §103(a) over the combination of the Ayrton, Zahaykevich and Temple references is improper, and withdrawal thereof is respectfully requested. Dependent claims 13-15 are also submitted to be in condition for allowance at least in view of their dependence on claim 12.

Newly added claim 15 recites that the time interval between each laser pulse having a first energy, and each successive laser pulse, is set to be sufficient to allow the

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residual radiation of each laser pulse having a first energy to dissipate. Support for this limitation may be found, inter alia, on page 6 of the specification of the present application. Applicant's submit that this feature is not disclosed in the applied prior art.

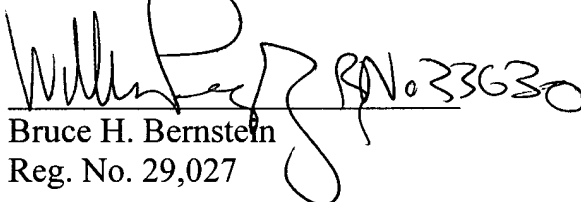
Based on the above, it is respectfully submitted that this application is now in condition for allowance, and a Notice of Allowance is respectfully requested.

SUMMARY AND CONCLUSION

Entry and consideration of the present amendment, reconsideration of the outstanding Office Action, and allowance of the present application and all of the claims therein are respectfully requested and now believed to be appropriate. Applicant has made a sincere effort to place the present invention in condition for allowance and believes that he has now done so.

Should the Examiner have any questions or comments regarding this response, or the present application, the Examiner is invited to contact the undersigned at the below-listed telephone number.

Respectfully submitted,
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